MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2017/2018

DET5028 – INDUSTRIAL ELECTRONICS

(Diploma in Electronic Engineering - All sections/groups)

28 OCTOBER 2017

9:00 AM – 11:00 AM

(2 HOURS)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **7** pages with **5** questions.
2. Answer **ALL** questions. All necessary working steps **MUST** be shown.
3. Write all your answers in the answer booklet provided.

QUESTION 1 [20 marks]

(a) An escalator in a shopping complex is designed to have a switch (SW) to control its motor (M) as shown in the PLC ladder diagram in *Figure 1-1*. For each of the following cases, modify the rung of the ladder diagram accordingly. **Consider each case separately as they are not related to each other.**

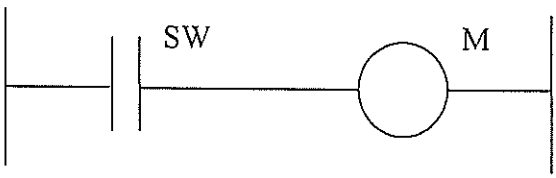

Figure 1-1

(i) Start the escalator once the switch is **momentarily** pressed.

[2 marks]

(ii) Assume the motor is running and latched. Now, add a stop switch (STOP) in order to turn it off during shutdown or emergency.

[3 marks]

(iii) Add a motion sensor (MS) to detect people approaching the escalator so that the motor can be turned on automatically, besides using the manual switch.

[2 marks]

(iv) Turn on an indicator light (IL) as a second output to display the activation of the motor.

[2 marks]

(b) Design a ladder diagram for an automatic door control as shown in *Figure 1-2* that requires the specifications described below. X0, X1, X2, Y0 and Y1 refer to the I/O assignment as described in *Table 1-1*. **The answer should be drawn into a single ladder diagram only.**

(i) When someone enters the sensing field of the infrared sensor, the opening motor starts working to open the door automatically. It will stop when the

Continued...

door touches the opening limit switches.

(ii) After the door touches the opening limit switches for 7 seconds and nobody enters the sensing field during that time, the closing motor starts working to close the door automatically. It will stop when the closing limit switches touch together.

(iii) The closing action is stopped immediately if someone enters the sensing field during the door closing process, and the door will be opened once again.

Note: The opening and closing motors will be latched after they are turned on.

Table 1-1

Input Port	External Device
X0	Infrared Sensor
X1	Closing Limit Switch
X2	Opening Limit Switch

Output Port	External Device
Y0	Opening Motor
Y1	Closing Motor

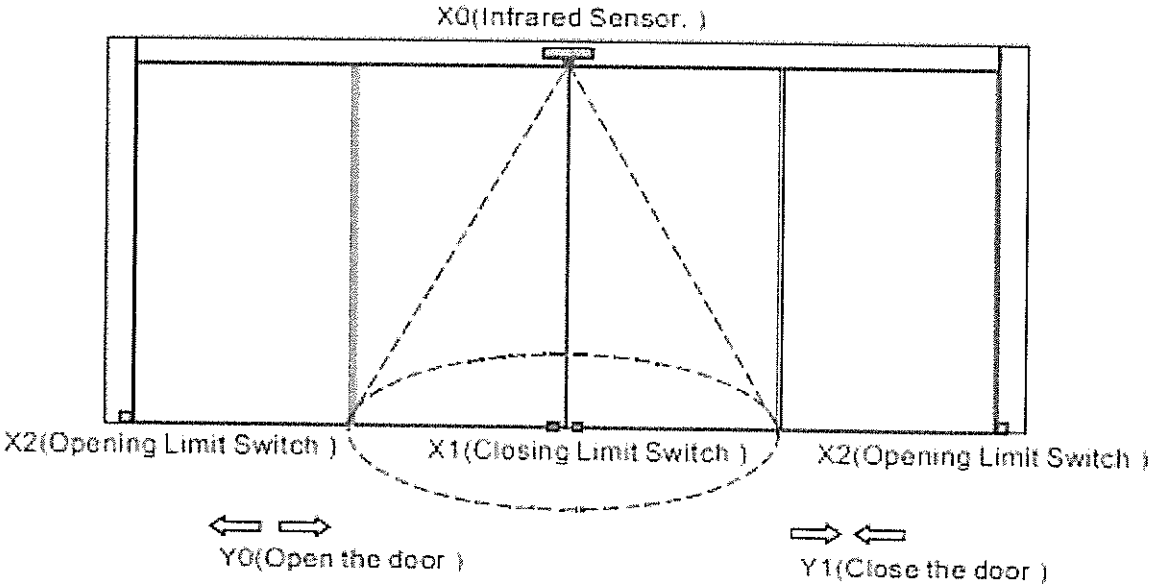

Figure 1-2

[11 marks]

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QUESTION 2 [20 marks]

(a) Explain how a single-pole, double-throw (SPDT) switch can be used in a lamp brightness control circuit as shown in *Figure 2-1(a)*. The switch has a center-off position for the wiper. The lamp waveforms for dim and full illumination are shown in *Figure 2-1(b)*.

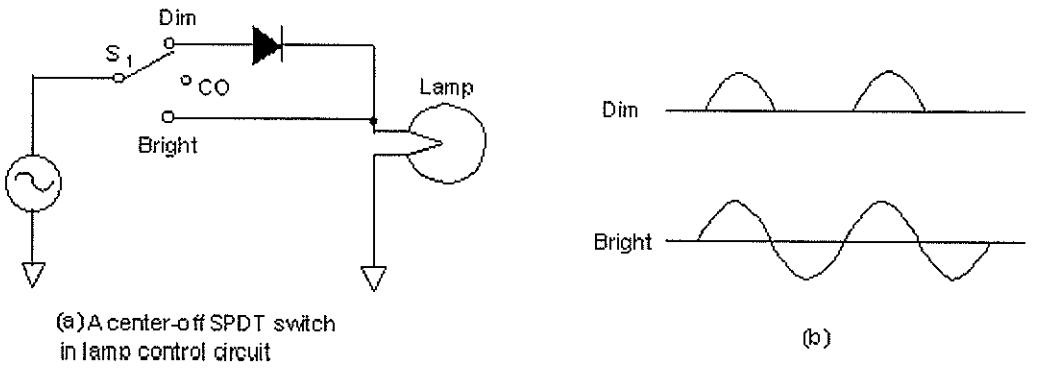

Figure 2-1

[4 marks]

(b) Refer to the circuit as shown in *Figure 2-2*. Given that $r_{BB} = 8.5\,k\Omega$, $\eta = 0.62$, $V_V = 1.5\,V$, $I_P = 4.7\,\mu A$ and $I_V = 5.3\,mA$. Determine:

(i) The values of r_{B1} and r_{B2} when the UJT is not in operation.

[4 marks]

(ii) The rise time and discharge time if $r_{B1} = 50\,\Omega$ during the discharge phase.

[8 marks]

(iii) The minimum and maximum values of R that could be used in the circuit.

[4 marks]

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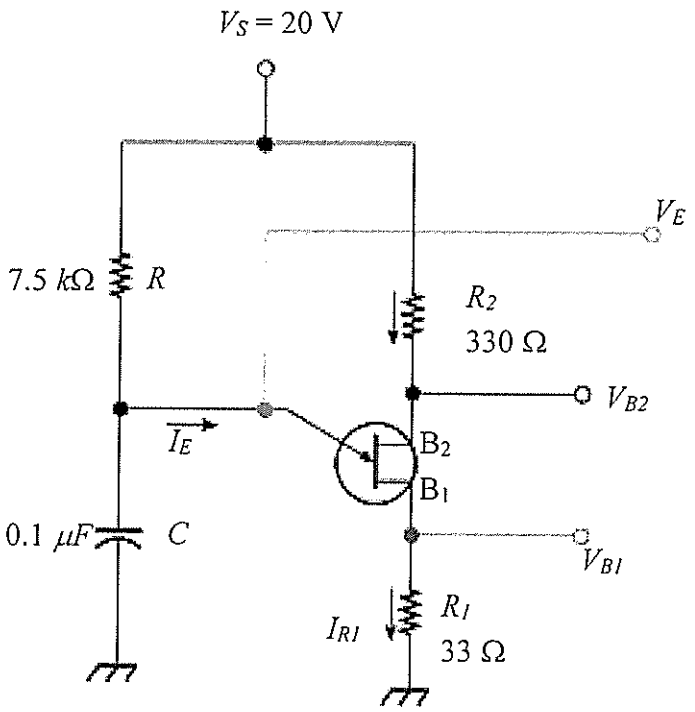

Figure 2-2

Continued...

QUESTION 3 [20 marks]

(a) Define negative temperature coefficient (NTC) of resistance and give one example of a temperature sensor that exhibits this characteristic.

[2 marks]

(b) An RTD with $R_T = 1\,k\Omega$ is placed in a circuit with a voltage of $5\,V$ across it, where:

- The temperature coefficient of resistivity is $\alpha = 0.003902/°C$.
- The resistance of the RTD at $25°C$ is $110\,\Omega$.
- The self-heating factor is $F_{SH} = 0.1°C/mW$.

Due to the self-heating problem of the RTD, determine the new value of temperature measurement that will be indicated by it at $180°C$ and the new value of resistance.

[10 marks]

(c) Determine the new length of a strain indicator wire in a strain gauge after it is strained if its original length was 12 mm. It has a gauge factor of 3 and $\varepsilon = 400\ \mu$. Calculate the new resistance of the wire having an original resistance of 500 Ω.

[8 marks]

Continued...

QUESTION 4 [20 marks]

(a) Explain briefly the operation of a photodiode.

[4 marks]

(b) An optical shaft-encoder has a 10:1 gear ratio and an optical disk with 15 slits. It also has a direction-indicating ability. Its output is a 9-bit signed magnitude binary, with the 9th bit on the far left representing either sign bit 0 for positive (disc rotating clockwise), or 1 for negative (disc rotating counter clockwise).

(i) Calculate the resolution of the optical shaft-encoder.

[2 marks]

(ii) How far can the measured shaft turn without exceeding the capacity of the counter?

[4 marks]

(iii) What direction and amount of shaft movement represented by a binary output of 0 1011 0010 ?

[4 marks]

(iv) If the measured shaft moves 3/5 turn in counter clockwise rotation, what is the content of the binary counter?

[3 marks]

(v) If the measured shaft moves 240° in clockwise rotation, what is the content of the binary counter?

[3 marks]

Continued...

QUESTION 5 [20 marks]

(a) Explain what is Counter Electromotive Force and how it affects the effective voltage in the armature circuit of a motor.

[4 marks]

(b) Suppose that a shunt-configured dc motor has an armature winding resistance $R_A = 2.8\,\Omega$, an applied voltage $V_A = 230\,V$, a proportionality constant $k_{E_C} = 0.08017$, a field winding resistance $R_F = 169\,\Omega$, a magnetic field strength $B = 0.95\,T$ and a proportional factor $k_\tau = 0.83$. If the motor generates 226.22 V, find the following:

(i) The armature current.

[2 marks]

(ii) The motor's mechanical power.

[8 marks]

(iii) The proportionality factor, $k_{E_{C3}}$.

[4 marks]

(iv) Suppose the mechanical load increases and more torque is required such that the new torque value is 3.8 N-m, calculate the new armature current.

[2 marks]

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